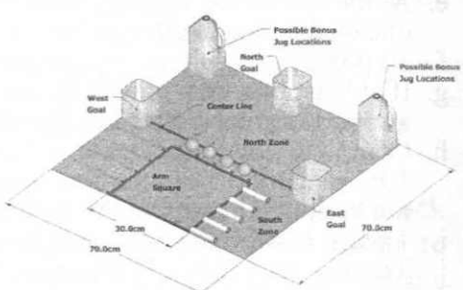
ROBOT ARM

Read the General Rules in the manuals and on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Prior to the competition teams must design, build, document and test one robotic device to move scoreable items.
   A TEAM OF UP TO: 2 **IMPOUND:** No **EYE PROTECTION:** #5 **APPROX. TIME:** 10 min.
2. **EVENT PARAMETERS:** Teams must provide one Device. Teams without proper eye protection must be immediately informed of that and given a chance to obtain eye protection if time allows, otherwise not be allowed to compete and are scored as a no-show. The Supervisor provides the Competition Area and items.
3. **CONSTRUCTION PARAMETERS:** The Device includes the Arm(s), an optional permanently attached Base, **optional detachable passive Arm end effectors** (parts that interact with the items on the Competition Area), remote control box(es) (e.g., radio control; infrared; connector wires, tubes, hoses, etc.).
   a. The Arm(s) may be attached to a Base. All parts (except the control box(es)/connections) in the ready to run position must fit inside a 30.0cm x 30.0cm x **100.0cm high rectangular prism**. The Arm(s) is not restricted to these dimensions during the run and must be attached to the floor only by the force of gravity. Control boxes may be contained within the base or arm and robots may be fully autonomous.
   b. The Device may use modified kit parts and have any number of arms and joints.
   c. Competitors must not impart energy directly onto the Arm(s) (i.e., all end effector movements must be powered by stored energy in the device components).
   d. Commercial batteries, not exceeding 14.4 volts as labeled, may be used to energize each of the Device's electrical circuits. Multiple batteries may be connected in series or parallel as long as the expected voltage output across any points does not exceed 14.4 volts as calculated using their labeled voltage. **All power sources must be contained either in the robot square or as part of the control box.**
   e. **While pneumatics are permitted, storage devices must not start with positive gauge pressure.**
   f. Arm functions may have independent circuits, sources of electrical energy and/or control mechanisms.
   g. Radio control equipment used for this event must operate on frequencies designated by the FCC for surface devices. The frequency must be marked by the manufacturer on the transmitter. Allowable frequencies are: 75 MHz band (75.41 - 75.99 MHz), 27 MHz band (26.995 - 27.255 MHz), 49 MHz band (49.8302 - 49.890 MHz) or 2.4 GHz **(Bluetooth is acceptable.)** Devices using other frequencies must not be allowed to compete.
4. **DOCUMENTS:** In addition to the Device, teams must develop and submit at check-in (or as announced by the tournament director) the following three technical documents-examples available at http://www.soinc.org
   a. Engineering Drawings (hand-drawings are acceptable), either as 3-views or projected views, of the basic structure of the Device that must show (with labels):
      i. All motors and/or actuators on the Arm(s)
      ii. All energy sources
      iii. All Arm(s) end effectors
      iv. Controls the competitors are using to interact with the Arm(s)
   b. Individual Component List for every component of the Arm(s), except fasteners, with the following information. A preassembled component (one not assembled by the team) counts as one component:
      i. Name **and quantity** of each component
      ii. Location/vendor from which the component can be obtained
      iii. Two or more key properties of the component (e.g., weight, dimensions, voltage rating, etc.)
      iv. Energy source of the component (n/a is an acceptable entry if the component is a voltage/current source or if the component is not energized)
   c. Operating Description
      i. Device reaction to each control input; ii. Tentative/Proposed plan of movement (i.e., which items in the Competition Area will be moved; how the Device will move each item)
5. **COMPETITION AREA:** The Competition Area is a taped 70.0 cm x 70.0 cm square using the inside edge of tape to mark the area. The Supervisor must designate each of the 4 sides as North, East, South, and West. See www.soinc.org for **expanded view** of Area



   a. A taped 30.0 cm x 30.0 cm square (the "Arm Square") is marked inside of, centered on, and touching the South edge of the Competition Area. The **inside** tape edge is used to mark the Arm Square.
   b. Goal Boxes are labeled W, N, & E and placed inside the Competition Area centered on the W, N, & E sides, touching the edges of the Competition Area. Goal boxes must be a bottom portion of a half-gallon milk jug, cut to a height between 9.5 and 10.5 cm with the opening facing up. They must not be secured to the surface.
   c. The Competition Area is divided into North and South Zones along a 35.0 cm Center Line that is defined by the northern edge of a piece of tape running from the East to West edges of the Competition Area.
   d. At the beginning of each Competition Time, 5 "½ inch nominal size" PVC pipes (9.5 – 10.5 cm long), 5 ferromagnetic nails (9.5 – 10.5 cm long), and 5 unsharpened #2 pencils are **evenly spaced along the full**

length of the arm square and placed perpendicular to the edges of the Arm Square in a row. The head of each nail, the eraser end of each pencil, and an end of each pipe touches the edges of the Arm Square, and points away from it.

e. The pencils are placed along the West edge, the nails along the North edge and the pipes along the East edge. 4 **Ping-Pong Balls are centered, one each,** between each pair of nails. **Ping-Pong Balls must remain undamaged.**
f. One unmodified half-gallon jug with the cap removed (Bonus Box) is placed at one of the two North corners of the Competition Area (must be the same for all teams). It must not be secured to the ground.
g. The Device may move any boxes anywhere **inside or outside** the Competition Area after Competition Time begins.

6. **COMPETITION**: At check in, the Event Supervisor inspects and measures the device, selects 4 items from the technical documentation, and has the competitors point them out on their device.
   a. Teams have **3** minutes of Prep Time to set up and test their Device in the Competition Area.
   b. Teams have 3 minutes of Competition Time to complete the task of moving the scoreable items, which begins once the team notifies the Supervisor they are ready and initiate movement of the Device.
   c. The run must stop if any of the following occur (This does not move the team to a lower tier.): **i.** Three (3) minutes has elapsed; **ii.** The team says, "Stop"; **iii.** The team steps onto the Competition Area a second time after being warned once; **iv.** Any end effectors are moved by anything besides stored energy in the Device; **v.** Any part of the Device touching the Arm Square surface exits the Arm Square; **vi.** The Device is physically moved by the connections to the control box(es); **vii.** The Arm(s) become detached from the optional Base **(not including optionally detachable passive end effectors).**
   d. Teams who wish to file an appeal must leave their documentation and Device with the Supervisor.
7. **SCORING:** High score wins.
   a. If the team or control box(es) connections move any of the scoreable items (pencils, nails, pipes, batteries), or if any scoreable item touches the surface outside of the Competition Area, even if it is under the control of the Arm(s), that item is out of play and must not be used to attain any points. The Goal and Bonus Boxes may touch the surface outside the Competition Area.
   b. Teams receive points for items completely supported by Goal Boxes (regardless of goal box location) at the end of the Competition Time as listed below. Points attributed to an item in the Goal Box must only be counted if that item was placed while the box was upright.

	West Goal Box	North Goal Box	East Goal Box
Pencil	**2**	**3**	2
Nail	2	**2**	**3**
PVC	**3**	2	**2**

   c. Four points for each Goal Box that completely supports one or more **ping-pong balls**. (12 pts max.)
   d. **Bonus Points: Teams will be** awarded 0.02 points for each 1 cm above the surface of the competition area that a scorable ping pong ball is held by the arm. The part of the arm used to raise the ping-pong ball must have been previously used to score at least 1 point. The measurement will be taken after time stops. The lowest point of the ball must be visible from the ground; measurement will be taken from this point. The ping-pong ball must be stable; if it is moving, the event supervisor must wait until the arm and ball come to rest. Raising the ping-pong ball must be the team's final task to receive the Bonus Points.
   e. At the end of the run, any item that is completely within the North Zone and not completely supported by one of the Goal or Bonus Boxes receives 1 point.
   f. 10 points for each item type (except **ping pong balls**) completely in the Bonus Box. (30 points max.)
   g. If at least one item is fully in the North Zone or supported by a Goal Box when time is stopped 5 points are awarded for each Goal Box that did not lie completely sideways at any time. (15 points max.)
   h. Complete documents receive their full score. For each complete document missing (4a-c), teams receive a 10% penalty off of their final score (up to 30%). For each incomplete document (e.g., the Drawings do not include a motor on the device) teams receive a 5% penalty off of their final score (up to 15%).
   i. 1 point is subtracted for each missing or incorrectly identified item during the check-in inspection.
   j. Ties are broken by: 1) **Shortest** Competition Time; 2) Least number of electrical, hydraulic, or pneumatic motors. Cooling fan motors used only to cool are not counted; 3) **Lowest** labeled circuit voltage.
   k. Tiers:
      i. Tier 1: Devices that meet all requirements are ranked by highest score
      ii. Tier 2: Devices that fail to meet a spec. under "Construction Parameter" are ranked by highest score.
      iii. Tier 3: Devices with Competition violations are ranked by highest score.
      iv. Tier 4: Participation Points only: Devices that violate the frequency rules; that have no capability, by design or construction, to score points via moving objects; or are unable to compete.

Recommended Resources: All references, sample documents and training resources including the **Robot Arm DVD** are available on the Official Science Olympiad Store or Website at http://www.soinc.org